Bachelor of Technology Partnership

Course Outline

1. COURSE INFORMATION

Session Offered	SUMMER 2016	
Course Name	Finite Element Analysis	
Course Code	ENG TECH 3FA3	
Program Name	Civil Engineering and Infrastructure Technology Manufacturing Engineering Technology	
Calendar Description	Matrix operation. Direct stiffness method to form global stiffness matrix and solve problems. Derivation and application of rod, truss, beam, frame and 2D element. Dynamic and thermal stress analysis using FE method. Create and analyze structure models with ANSYS.	
Instructor	Christopher Young	E-Mail: cyoung@avenue.cllmcmaster.ca

2. COURSE SPECIFICS

Course Description

Instruction Type

Code	Type	Total Hours
C	Classroom Instruction	**21**
L	Laboratory, workshop or fieldwork	**18**
T	Tutorial	
DE	Distance Education	
	TOTAL HOURS	**39**

Resources

ISBN	Textbook Title & Edition	Author & Publisher
ISBN-10: 0-13-189080-8	Finite Element Analysis, Theory and Application with ANSYS Third Edition	Saeed Moaveni & Pearson
Other Supplies		

Prerequisite(s)	ENG TECH 3ML3, ENG TECH 3MA3
Corequisite(s)	
Antirequisite(s)	ENG TECH 2FE3, 3FE3, 3FN3
Course Specific Policies	This course will be using a range of software. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor. The instructor may also use other software including: e-mail, Avenue, LearnLink, web pages, capa, Moodle, Thinking Cap, etc. **Missed quiz and late lab submissions will not be marked.**
Departmental Policies	Students must maintain a 3.5/12 GPA to continue in the program. In order to achieve the required learning objectives, on average, B.Tech. students can expect to do at least 3 hours of “out-of-class” work for every scheduled hour in class. “Out-of-class” work includes reading, research, assignments and preparation for tests

	and examinations. Where group work is indicated in the course outline, such collaborative work is mandatory. The use of cell phones, iPods, laptops and other personal electronic devices are prohibited from the classroom during the class time, unless the instructor makes an explicit exception. Announcements made in class or placed on Avenue are considered to have been communicated to all students including those individuals that are not in class. Instructor has the right to submit work to software to identify plagiarism.	
3. SUB TOPIC(S)		
Week 1 May 5, 2016	- Matrix Algebra ○ Definition of a Matrix ○ Matrix Operation ○ Inverse of a Matrix by Row Reduction ○ Solving simultaneous equations using Gauss Elimination method and Cramer's Rule - Uniaxial Rod Elements ○ Assembling global stiffness matrix of a spring assemblage using direct stiffness method ○ Specify boundary conditions for structure models ○ Work equivalent loads	Chp 2
Week 2 May 12, 2016	**Quiz 1** - Plane Truss Elements ○ Transformation of vectors two dimensions ○ Assembling global stiffness matrix in global reference frame - Principle of Minimum Potential Energy Approach to Derive Rod Element Equations ○ Development of rod element shape functions ○ Express stress/strain relationship in matrix notation ○ Derive Rod Element stiffness matrix from strain energy ○ Comparison of Finite Element Solution to Exact Solution for Rod Element	Chp 1.4-1.5 Chp 3 + Notes Chp 5.1, 5.2, 5.4 + Notes
Week 3 May 19, 2016	**Quiz 2** - Principle of Minimum Potential Energy Approach to Derive Beam Element Equations ○ Development of beam element shape functions ○ Express stress/strain relationship in matrix notation ○ Derive Beam Element stiffness matrix from strain energy ○ Comparison of Finite Element Solution to Exact Solution for Rod Element - Frame Elements Solving structure models that combine beam and rod elements	
Week 4	**Quiz 3**	Chp 7.3, 9.3, 10.2

May 26, 2016	- Two Dimensional Finite Element
	  ○ Basic concepts of plane stress and plane strain
	  ○ Two-Dimensional state of stress and strain
	- Principle of Minimum Potential Energy Approach to Derive Constant-Strain Triangular Element Equations
	  ○ Development of triangular element shape functions
	  ○ Express stress/strain relationship in matrix notation
	  ○ Derive constant-strain triangular stiffness matrix from strain energy
	  ○ Demonstrate examples of other types of 2D plane elements
		+ Notes

Week 5 June 2, 2016	**Term Test**	
Week 6-10 June 9, 2016 June 16, 2016 June 23, 2016 June 30, 2016 July 7, 2016	**Lab 1-5**	
Week 11 July 14, 2016	**Practical Test**	

Week 12
July 21, 2016
	- Structural Dynamics with FE
	- Rod Element
	  ○ Derivation of Consistent Mass Matrix for Rod Element
	  ○ Modal Analysis of a Rod
	- Truss Element
	  ○ Derivation of Consistent Mass Matrix for Plane Truss Element
	- Beam Elements
	  ○ Derivation of Consistent Mass Matrix for Beam Elements
	  ○ Modal Analysis of a beam
	- 2D Elements
	  ○ Derivation of Consistent Mass Matrix for 2D Elements
	  ○ Modal Analysis of a 2D structure
		Chp 11
		+ Notes

Week 13
July 28, 2016
	- Thermal Stress
	  ○ Formulation of thermal stress problem
	  ○ Evaluate thermal force matrix
	  ○ Thermal stress analysis of rod element, truss element, 2D plane element
		Notes

August 4, 2016	**Final Exam**	

Note: this structure represents a plan and is subject to adjustment term by term. The instructor and the university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes.

4. ASSESSMENT OF LEARNING	**Weight**

Quizzes (6 Quizzes)	**10%**
Labs (5 Labs)	**10%**
Term Test (June 2, 2016)	**20%**
Practical Test (July 14, 2016)	**20%**
Final Exam (Aug 4, 2016)	**40%**
TOTAL	**100%**

Percentage grades will be converted to letter grades and grade points per the University calendar.

5. LEARNING OUTCOMES

1. Able to use direct stiffness method to solve finite element problems.
2. Understand and apply the concept of minimum potential energy to generate various types of element equations.
3. Solve structural, thermal problems and modal analysis.
4. Able to use commercial code ANSYS to design problems into finite element models. Interpret and compare the results yield when using various types of elements. Explain the trends obtained from the model.
5. Implement various techniques such as symmetric, axisymmetric and localized mesh refinement to optimize computational time using ANSYS.

6. POLICIES

Anti-Discrimination

The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.
http://www.mcmaster.ca/policy/General/HR/Anti-Discrimination%20policy.pdf

Academic Integrity

Attention is drawn to the Statement on Academic Ethics and the Senate Resolutions on Academic Dishonesty as found in the Senate Policy Statements distributed at registration and available in the Senate Office. Any student who infringes one of these resolutions will be treated according to the published policy.

Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3, located at:
http://www.mcmaster.ca/univsec/policy/AcademicIntegrity.pdf

Requests for Relief for Missed Academic Term Work (Assignments, Mid-Terms, etc.)

The McMaster Student Absence Form is a self reporting tool for **Undergraduate Students** to report absences that last up to 5 days and provides the ability to request accommodation for any missed academic work. Please note, this tool cannot be used during any final examination period.
You may submit a maximum of 1 Academic Work Missed requests per term. It is YOUR responsibility to follow up with your Instructor immediately regarding the nature of the accommodation.
If you are absent more than 5 days or exceed 1 request per term you MUST visit your Associate Dean's Office (Faculty Office). You may be required to provide supporting documentation.
This form should be filled out immediately when you are about to return to class after your absence.
http://www.mcmaster.ca/msaf/

E-Learning Policy

Consistent with the Bachelor of Technology’s policy to utilize e-learning as a complement to traditional classroom instruction, students are expected to obtain appropriate passwords and accounts to access Avenue

To Learn for this course. Materials will be posted by class for student download. It is expected that students will avail themselves of these materials prior to class. Avenue can be accessed via http://avenue.mcmaster.ca

Communications

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
- Use the university provided e-mail address or maintain a valid forwarding e-mail address.
- Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, by fax, or by e-mail to the student's designated primary e-mail account via their @mcmaster.ca alias.
- Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.
- To check their McMaster/Avenue email and course websites on a regular basis during the term.

Turnitin (Optional)

This course will be using a web-based service (Turnitin.com) to reveal plagiarism. Students will be expected to submit their work electronically to Turnitin.com and in hard copy so that it can be checked for academic dishonesty. Students who do not wish to submit their work to Turnitin.com must still submit a copy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to www.mcmaster.ca/academicintegrity

Protection of Privacy Act (FIPPA)

The Freedom of Information and Protection of Privacy Act (FIPPA) applies to universities. Instructors should take care to protect student names, student numbers, grades and all other personal information at all times. For example, the submission and return of assignments and posting of grades must be done in a manner that ensures confidentiality.
http://www.mcmaster.ca/univsec/fippa/fippa.cfm

Academic Accommodation of Students with Disabilities Policy

Student Accessibility Services (SAS) is committed to the continuous improvement of accessibility for students with disabilities. Students are encouraged to contact SAS as early as possible before each term starts to become familiar with the services offered and to confirm their accommodations.

Students must forward a copy of the SAS accommodation to the instructor of each course and to the Program Administrator of the B.Tech. Program immediately upon receipt. If a student with a disability chooses NOT to take advantage of a SAS accommodation and chooses to sit for a regular exam, a petition for relief may not be filed after the examination is complete. http://sas.mcmaster.ca

Student Code of Conduct

The Student Code of Conduct (SCC) exists to promote the safety and security of all the students in the McMaster community and to encourage respect for others, their property and the laws of the land. McMaster University is a community which values mutual respect for the rights, responsibilities, dignity and well-being of others. The purpose of the Student Code of Conduct is to outline accepted standards of behavior that are harmonious with the goals and the well-being of the University community, and to define the procedures to be followed when students fail to meet the accepted standards of behavior. All students have the responsibility to familiarize themselves with the University regulations and the conduct expected of them while studying at McMaster University.

http://www.mcmaster.ca/univsec/policy/StudentCode.pdf